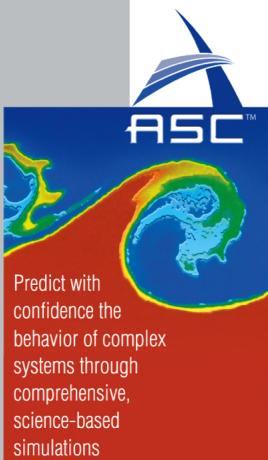


Scientific Computing for National Security



BlueGene/L capabilities expanded to better serve the national mission



The NNSA BlueGene/L supercomputer housed at Lawrence Livermore National Laboratory was named the world's fastest computer for a sixth straight time, according to the Top500 list released June 2007.

BlueGene/L redefines high-performance computing

BlueGene/L—first on the June 2007 Linpack TOP500 list of supercomputers with a sustained world-record speed of 280.6 teraFLOPS—is a revolutionary, low-cost machine delivering extraordinary computing power for the nation's Stockpile Stewardship Program. Having supported scientists in answering critical questions about plutonium aging (a key to understanding the life expectancy of nuclear weapons), the machine has been expanded to better serve the national security mission.

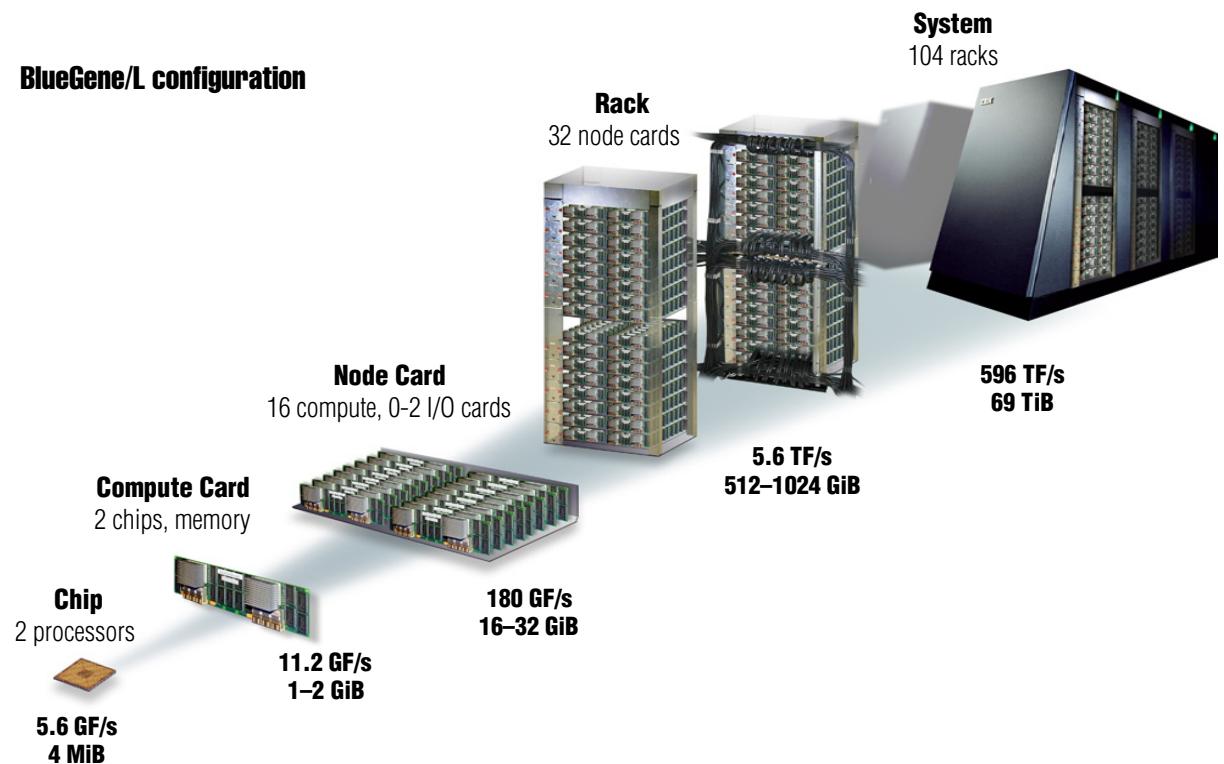
Stockpile stewardship is the Department of Energy/National Nuclear Security Administration's (DOE/NNSA) effort to ensure the safety, security, and reliability of the nation's nuclear deterrent without underground nuclear testing. BlueGene/L, used by scientists at Livermore, Los Alamos, and Sandia National Laboratories, was developed in partnership with IBM. Breakthrough simulations run on the machine over the last two years have earned three Gordon Bell Prizes, the hallmark award for high-performance computing. BlueGene/L is also a computational science research machine for evaluating advanced computer architectures.

In June 2006, BlueGene/L set a new world mark for a scientific application with a sustained performance of 207.3 teraFLOPS on the "Qbox" computer code for conducting materials science simulations. This established a new benchmark in the capability to perform predictive simulations of large, complex high-Z metals relevant to stockpile science and earned the 2006 Gordon Bell Prize for peak performance.

The BlueGene/L expansion will provide one more step in ratcheting ASC applications up to petascale performance. Specifically, the expansion will provide the resource for:

- Improving models for known physical processes
- Identifying and then modeling physics questions
- Quantifying uncertainty (for many classes of simulations)
- Improving the performance of complex models and algorithms in macroscale simulation codes
- Scaling integrated weapons calculations to very high processor counts

BlueGene/L configuration



BlueGene/L technology builds a supercomputer one dual-processor chip at a time. Chips are aggregated into compute cards, which are then assembled into node cards. Each rack holds 32 node cards, and the full machine now comprises 104 racks.

The supercomputer's current configuration is characterized by system-on-a-chip (SOC) design technology and low-cost, low-power, embedded microprocessors. SOC design provides an extreme level of integration with all computing and network interfaces on a single custom application-specific integrated circuit only about 11 millimeters on a side. Low-power processors are critical to the design that enables BlueGene/L to achieve a compute density that currently provides 1,024 nodes (2,048 processors) and over 5 teraFLOPS in a single air-cooled cabinet. Previously, BlueGene/L boasted a peak speed of more than 360 teraFLOPS, a total memory of 32 tebibytes, and power of 1.5 megawatts, all on machine floor space of 2,500 square feet. The expanded configuration is shown below in comparison with the previous specifications.

BlueGene/L expansion in partnership with IBM

Expanded	Attribute	Previous
596 teraFLOPS	Peak symmetric mode rate	367 teraFLOPS
69 TiB (69×2^{40} bytes)	Aggregate memory	32 TiB (32×2^{40} bytes)
$1.9 \text{ PB} (1.9 \times 10^{15} \text{ bytes})$	Aggregate global disk	$1.01 \text{ PB} (1.01 \times 10^{15} \text{ bytes})$
$35.6 \text{ GB/s} (35.6 \times 10^9 \text{ bytes})$	Delivered I/O bandwidth	$25.6 \text{ GB/s} (25.6 \times 10^9 \text{ bytes})$
Dual PowerPC 440	Microprocessor technology	Dual PowerPC 440
$1664 \times 1\text{-Gb/s Ethernet}$	External networking (in 10^9 bits/s)	$1024 \times 1\text{-Gb/s Ethernet}$
106,496 (212,992)	Number of nodes (processors)	65,536 (131,072)
$\sim 67\% 512 \text{ MiB} (512 \times 2^{20} \text{ bytes})$	Memory per node	$512 \text{ MiB} (512 \times 2^{20} \text{ bytes})$
$\sim 33\% 1 \text{ GiB} (2^{30} \text{ bytes})$		